Advanced Display Trends and China Growth

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Electronics Evolution Calls for Display Innovation

- Display is becoming the #1 differentiating factor of consumer electronics
- The differences in semiconductor content in gadgets are fast diminishing
- Display form factor innovation becomes new driver in addition to visual effects
New Display Era on the Horizon

**1st Wave**
- Laptop
- PC

**2nd Wave**
- LCD Era
- CRT replacement
- Monitor

**3rd Wave**
- Large Screen TV

**4th Wave**
- Smart Phones & Tablets
  - Notebooks

**5th~6th Wave**
- 4K2K TV; OLED TV
- Flexible Display

**Advanced Display Era**
- Mobile revolution
- New TV technologies

Source: DisplaySearch, Applied Materials
Display Technology Transitions

<table>
<thead>
<tr>
<th>SIZE</th>
<th>TODAY</th>
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</thead>
<tbody>
<tr>
<td>TV</td>
<td>40” 55” 70”</td>
</tr>
<tr>
<td>PHONE</td>
<td>3.5” 4.5” 5”</td>
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<table>
<thead>
<tr>
<th>RESOLUTION</th>
<th>TODAY</th>
</tr>
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<tbody>
<tr>
<td>TV</td>
<td>HD &gt;326ppi 4K &gt;600ppi 8K</td>
</tr>
<tr>
<td>PHONE</td>
<td>&gt;700ppi</td>
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<table>
<thead>
<tr>
<th>FORM FACTOR</th>
<th>TODAY</th>
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<table>
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<tr>
<th>TRANSISTOR</th>
<th>DISPLAY</th>
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<tbody>
<tr>
<td>LTPS</td>
<td>LCD OR OLED</td>
</tr>
<tr>
<td>a-Si</td>
<td>MOx FLEX OLED</td>
</tr>
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- **Power consumption** ↓
- **Transistor density** ↑
- **Electron mobility** ↑
Optimizing Resolution, Power & Form Factor

- **Standard LCD**
  - Liquid Crystal
  - Color Filter
  - a-Si TFT
  - LED
  - iPhone3 163ppi

- **High-Res LCD**
  - Liquid Crystal
  - Color Filter
  - LTPS or MOx TFT
  - LED
  - iPhone5 326ppi

- **OLED**
  - RGB OLED
  - TFE
  - LTPS TFT
  - Mobile Device 440ppi
Yield Challenges with Large Size Display

LARGE AREA PRECISION MATERIALS ENGINEERING

GEN 8.5 GLASS
5.5m² = 59 ft²

2.2m

2.5m

300mm Wafer

HD

93% Yield

32"

Killer Defect

Repairable Defect

Uniformity 3X improvement

Particles > 10x Density Reduction

4K TV

83% Yield

55"

3K TV

33% Yield

55"

4K TV

0% Yield

55"

90"

PRECISION MATERIALS ENGINEERING OPPORTUNITY

5.5m²=59ft²
CVD Uniformity Requirements with Advanced Displays

In-Cell Touch
- Steady transistor capacitance to minimize noise
- Film uniformity improves transistor stability

High-Resolution
- Smaller pixels require smaller capacitance (Cs) and TFTs
- Film uniformity greater effect on TFT capacitance

OLED TFT
- Current driven requires tighter capacitance tolerance
- Film uniformity ensures TFT driver performance
Applied Materials Enables the Most Exciting Industries on Earth

**SEMICONDUCTOR**

- 20,000,000x reduction in COST PER TRANSISTOR in 30 years\(^1\)

**DISPLAY**

- 20x reduction in COST PER AREA in 15 years\(^2\)

**SOLAR**

- 3x reduction in COST PER WATT in 4 years

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1 Source: SIA, IC Knowledge LLC
2 Source: Display Search, Nikkei BP, Applied Materials
Applied Materials Display Products

CORE LCD EQUIPMENT

- TV
- Monitor
- Notebook
- Mobile

NEW EQUIPMENT SEGMENTS

- New TV
- Tablet
- Smart Phone

ADAPTING

- LTPS
- Metal
- Oxide
- OLED
- Hi Res
- Touch

- +LTPS
- + Metal oxide
- + TFE
- + Advanced Test
- + Touch

Full range of solutions to device performance & yield issues
China Becomes The Most Attractive Market

#1 Display Market
- 22% of WW TV
- 22% of WW Smartphone

#1 Technology Adoption
- 43% TV are smart TVs
- 40% TV are 3D TVs

#1 Display Manufacture
- 70% LCD TV modules

#1 Display investment
- 50% display investment

R&D Activity Ramping

1 Source: DisplaySearch, Strategy Analytics
2 Source: AVC, as of Q1'2013
China Has Established FPD Value Chain

Supporting China Display industry with advanced manufacturing equipment
Applied Materials and AKT in China

29 years of experience in China

AMC Founded in 1984
- Opened service center in Beijing as the first foreign WFE company to enter China market
- 8 sales/service, R&D/manufacturing, and training centers
- 800 RTF employees

AKT Locations (Since 2004)
- Beijing, Shanghai, Chengdu, Hefei, Shenzhen
- 100 RTF employees for Sales/Service, sharing AMC infrastructure

Applied Materials China
- RD&E and/or operations centers
- Sales and/or Service Offices

Display/AKT
- AKT offices
- Existing Display customer fabs

- Gen 2.5
- Gen 5
- Gen 8.5
- Touch panel
- Touch panel
- Gen 4.5
- Gen 4.5
- Gen 4.5
- Gen 5.5
- Touch panel
- Gen 6
- Touch panel
- Gen 6
- Touch panel
- Gen 5
- Gen 5
- Gen 4.5
Industry has entered Advanced Display Era, with proliferation of hi-resolution, OLED, and touch.

Applied Materials is helping enable new displays with equipment and processes that improve yield of new technologies.

Together, we are applying technology and experience for the success of the China TFT-LCD industry.